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This randomized controlled trial feasibility study tested the effectiveness of an iPad® application (app) social script intervention for children with autism spectrum disorder (ASD) going to imaging and their parent (*n* = 32 parent/child dyads). Parents of the children exposed to the app (*n* = 16) had lower state anxiety compared to the parents whose children were not exposed to the app (*n* = 16) (effect size 0.33). Children exposed to the app had fewer externalized challenging behaviors than the control group (effect size 0.56). The results demonstrate feasibility and efficacy of the intervention. Further study of the iPad app is warranted.

Key words

Autism spectrum disorder, iPad app, Anxiety, Social script, Imaging

APPROXIMATELY 3 MILLION people in the USA have autism spectrum disorder (ASD) (Centers for Disease Control & Prevention, 2012). ASD is diagnosed according to criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) (American Psychiatric Association (APA), 2013). In the DSM-5, ASD is considered one disorder with symptoms organized in two domains: (1) impairments with social interaction and social communication, and (2) restricted interests and repetitive behaviors (APA, 2013). Accordingly, for some children with ASD, the totality of symptoms impedes medical imaging, such as x-rays and CT scans (Johnson and Rodriguez, 2013, Peacock et al., 2012). Coexisting health disorders, such as epilepsy, or gastrointestinal disorders, and accidental injuries, result in more and longer health care visits for children with ASD than for other children (Gurney et al., 2006, Lee et al., 2008, Liptak et al., 2006, McDermott et al., 2008). Due to limited time and experience with ASD (Tucker et al., 2008, Tucker and Spear, 2006), health care providers (HCPs) find it challenging to support these children and their parents in medical imaging (Tucker et al., 2008).

Background

Approximately 29–55 % of children with ASD have a diagnosed anxiety disorder (De Bruin et al., 2007, Simonoff et al., 2008). Anxiety for children with ASD tends to be exacerbated when they are not able to communicate their fears and frustration about unclear expectations for their cooperation with medical procedures (Davis et al., 2011, Johnson et al., 2013). Typically developing children may do well with a verbal explanation of a procedure, known as verbal foreshadowing (Brewer, Gleditsch, Syblik, Tietjens, & Vacik, 2006), and with distraction during the procedure (Koller & Goldman, 2012). However, parents of children with ASD frequently report that the environments in which medical procedures are performed are not prepared to address the anxiety and challenging behaviors of their children (Bultas, 2012, Kopecky et al., 2013). These behaviors include: (1) lack of co-operation with instructions, (2) internalized behaviors, for example, self-injury and (3) externalized behaviors, for example tantrums, and damaging property (Johnson and Rodriguez, 2013, Lam and Aman, 2007, van Ingen et al., 2010). The lack of preparation increases anxiety in the child and parent, and contributes to delays in procedure time, and hinders a child's successful completion of the procedure (Johnson & Rodriguez, 2013).

When a child is carefully prepared for a procedure, however, anxiety and challenging behaviors decrease (Brewer et al., 2006, Drake et al., 2012). Koller and Goldman (2012) emphasize the need to

study nuanced approaches for working with children with anxiety. One such approach to preparing a child and their parent is the social script.

A social script, like a social story™ (Gray, 2003) is a narrative with photographs and words, which step-by-step teaches a routine to help a child deal with uncertainty. It addresses a wide variety of interfering externalized behaviors, including aggression, during imaging procedures (Myles, Trautman, & Schelvan, 2004). From the child's perspective, it outlines expected behaviors and responses in a special format that accounts for the child's socialization difficulties (Gray, 2003) and promotes self-regulation (Thompson & Johnston, 2013). The most effective social stories are read immediately prior to a situation in which a targeted behavior is most likely to occur, are greater than 10 sentences long, and have a mix of photographs and words (Kokina & Kern, 2010). Further, Widen and Russell (2010) report that social scripts are stronger for cueing acceptable behaviors for a child with ASD (n = 120, 4–10 years), than are the facial expressions of HCPs. Thus, children with ASD who have trouble reading facial expressions benefit from social script format preparation to prevent challenging behaviors associated with the medical imaging.

Literature indicates that iPads are increasingly used for the delivery of social scripts and stories for children with ASD (Flores et al., 2012, Kagohara et al., 2013, Moore et al., 2013, Murdock et al., 2013, Vandermeer et al., 2013). For example, Murdock et al. (2013) utilized an iPad play story to increase pretend play skills for preschoolers with ASD (n = 4), with resultant behaviors maintained during a generalization opportunity 3 weeks later. No published research study has examined the effectiveness of a social script intervention for both parent and child, delivered via iPad application, on reducing child and parent anxiety, child challenging behaviors, and procedure time, with children with ASD undergoing medical imaging.

The purpose of this study is to examine effectiveness of the social script intervention “Going to Imaging” application (app) on anxiety, challenging behaviors, and procedure duration among children with ASD, and the anxiety of their parent. There were two study hypotheses. The first hypothesis was that children with ASD who are exposed to the app will have: (1) lower anxiety as measured by heart rate (HR) and blood pressure (BP), (2) exhibit fewer challenging behaviors as measured by the behavior observation tool developed for the study, and (3) shorter time to complete a procedure, compared with children with ASD exposed to treatment as usual (TAU).

The second hypothesis was that compared to parents of ASD children exposed to TAU, parents of children with ASD who are exposed to the app will have: (1) lower state anxiety as measured by the State Anxiety Inventory (STAI-S).

Theoretical Rationale

The Family Self-Management (FSM) Framework (Knafl and Deatrick, 1990, Knafl and Deatrick, 2003) guided the study. The FSM theory predicts that there are risk and protective factors and perceived individual and family outcomes, based on the family self-management tasks and skills (Knafl and Deatrick, 1990, Knafl and Deatrick, 2003, Knafl et al., 2013). Based on the FSM theory, parents of children with ASD tend to be protective, about their child's behavior, and vigilant in helping their child to cope with a stressful event (Larson, 2010, Marshall and Long, 2010, Woodgate et al., 2008). They often use social stories or scripts to prepare children for new situations (Kokina & Kern, 2010).

Accordingly, the iPad intervention for the health care setting was designed to be a protective factor that positively impacts the individual and family outcomes. The interplay between the risk factor (imaging procedure) and protective factors (preparation of child with a social script) are proposed to decrease parent anxiety and child challenging behaviors, which in turn will decrease imaging procedure time.

Methods

A pilot feasibility, experimental, randomized intervention with a TAU control group design was used to test the impact of the app on parent and child anxiety and child anxiety, child challenging behaviors, and time to complete the procedure. Computer scientists at the university performed the programming of the four procedure specific apps for MRI, CAT scan, x-ray and nuclear medicine. Each app has 10 screens of photos, for example, checking in to the imaging department and walking down the hall, with 1–2 sentences of text written at a first grade reading level (for e.g., “There may be lots of people in the room. That’s okay I will hold onto my toy).” The script for the apps was written in collaboration with hospital employee medical imaging department co-investigators and based on social script formatting that prepares a child by breaking down a procedure into steps, and provides a script of responses, leading to improvements in behavior and social functioning (Gray, 2003). A medical photographer took professional photos of children, hospital employees and imaging equipment used in the app. The P.I. used voice-recording software to capture a child's voice reading the script of the app. The experience of the child listening to the app and forwarding the screen was not timed, but is estimated to be 5 minutes.

Participants were randomly assigned to one of two groups: the intervention or TAU. The TAU included asking the parent and child if they had questions about the procedure. The study involved three data collection time points on the same day: (1) immediately before the iPad app intervention and (2) immediately after the intervention, and (3) during imaging (see Figure 1). One researcher collected the pre and post intervention data, and delivered the intervention or the TAU. A second researcher, who was blinded to intervention or TAU, collected the post-intervention data during imaging.

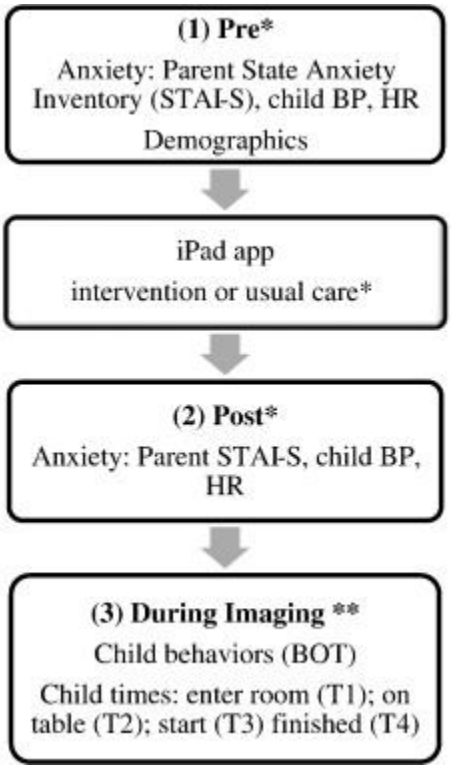

Figure 1. Study design with 3 data collection time points, concept measured and tools.
* Researcher 1.
** Researcher 2.

Sample and Setting

The study took place at a midwestern USA tertiary care children's health system. Children with ASD, and a parent, were recruited via institutional review board (IRB) approved flyers distributed in the community in the autism society newsletter, weekly email, and list serves. At the hospital, participants were recruited by flyers in specialty clinics, in mailings to patients with scheduled procedures, and in the emergency room. Flyers were also available to walk-in patients in the two hospital radiology departments in the main and suburban clinic. The research protocol was also listed on Clinicaltrials.gov. To be eligible for the study, the English speaking child, 3–18 years old, with an English speaking parent needed a parent reported DSM-IV based diagnosis of autism spectrum disorder (autism, PDD-NOS or Asperger Syndrome) (APA, 2000), and an existing order for medical imaging (MRI, CAT scan, x-ray, nuclear medicine, or ultrasound). Children with planned sedation or anesthesia were excluded because the iPad social script iPad application did not cover the steps of intravenous insertion or sedation.

Variables and Measures

Stress response, observable child challenging behaviors, and procedure duration were the primary variables of importance for this feasibility study. The state anxiety scale of the State-Trait Anxiety Inventory for Adults (STAI-S) was used to measures the stress response (Spielberger & Gorsuch, 1983) for parents, including feelings of apprehension, tension, nervousness, and worry as the experiences are felt at that moment. Each of the 20 items that make up the scale is given a weight of 1 to 4. Anxiety

scores are determined by adding the weighted scores for the 20 items. Scores can range from 20 indicating a low level of anxiety to 80 indicating a high level of anxiety. Uniformly high internal consistency levels have been reported with large, diverse samples (Spielberger & Gorsuch, 1983). The scale is written at the sixth grade reading level and takes approximately 10 minutes to complete (Spielberger & Gorsuch, 1983). Child stress was measured with HR and BP, via a battery operated wrist cuff provided by the research team, for the child, as children with ASD are not universally able to read and fill out surveys.

Child challenging behaviors were measured with the three subscales of the behavioral observation tool for children with ASD in the health care setting (BOT) developed for the study (Table 1). The tool has 28 items in 3 behavior domains (A) internalized: self-injury, (b) self-stimulatory, and (c) externalized: injury to others/hyperactivity. Within each subscale, behaviors are scored as present (1) or not present (0) in a 3-minute time frame of observation. Thus, the total score for the tool ranges from 0 to 28. Subscale scores for the BOT are calculated as follows: (A) six items of observation, for example, 'hits own head.' Scores range from 0 to 6, with 0 representing no behaviors and 6 representing all six self-injury behaviors; (B) seven items, for example, 'hand flapping.' Scores range from 0 to 7, with 0 representing no behaviors and 7 representing all seven self-stimulatory items; (C) fifteen items, for example, 'hitting other person.' Scores range from 0 to 15, with 0 representing no behaviors and 15 representing all fifteen self-stimulatory items.

Table 1. Behavior observation tool (scored as present = 1, not present = 0, scores range 0–27).

A. Internalized behavior/self-injury
1. Chewing own skin
2. Hits self on head
3. Hits other body part with hand
4. Hits head on surface
5. Hits other body part on surface
6. Picking own skin
B. Self-stimulatory/self-calming behavior
1. Covering ears with hands
2. Finger flicking
3. Hand flapping
4. Jumping
5. Rocking
6. Lining things up
C. Externalized behavior/activity
1. Biting care-giver
2. Crying/Tears
3. Grasping person's face or other body part
4. Hitting other person
5. Kicking other person
6. Laying on floor/throwing self down
7. Moving around room/exploring
8. Picking/chewing equipment

9. Pinching other person
10. Running out of room
11. Spitting other person
12. Staring at parent/caregiver
13. Swearing/Cursing
14. Throwing items
15. Yelling

As recommended by Lynn (1986), domain identification for the BOT was established based on a review of literature on the behaviors of children with ASD in the health care setting (Johnson & Rodriguez, 2013). Items in the domains were identified based on two focus groups (*n* = 10) of parents and health care providers of children with ASD (Johnson et al., 2013). Face validity was established with neuroscience nurses, radiology and electroencephalogram technologists. Content validity was established with parent experts (*n* = 11) in an online IRB approved survey, prior to use in the present study, per Lynn's (1986) method. Cronbach's alpha was 0.71. An inter-rater reliability of 90% was established for the tool by the research team. Research assistants and the principal investigator viewed 10 films of different children undergoing electroencephalograms. There was agreement on 9/10 films for total score on the BOT. In addition to the BOT there was a comment field where the researcher could record additional behaviors.

Procedure time was measured at four distinct time stamps: T1: Time child arrived in the imaging room; T2: Time child was instructed to get on table or stand in front of the x-ray machine; T3: Time the procedure started as noted by the time when the 'button' was pushed; T4: Time that the procedure was complete. Difference times were calculated as follows: D1 = T2-T1, D2 = T3-T2, and D3 = T4-T3. D1 represented time taken to follow the instructions to get from the doorway of the imaging room to the imaging equipment. D2 represented length of time it took to hold still once positioned for imaging. D3 represented length of time to complete imaging once started.

Procedure

Institutional review board (IRB) approval was obtained from both the university and the Children's Hospital prior to the study. Randomly ordered study packets determined which parents were in the intervention group or TAU group. No personal identifiers appeared on the questionnaires. There were two research team members per parent/child dyad. The first member consented the parent, assented the child, collected pre-intervention measures, and delivered the intervention and TAU or only the TAU. The intervention social story iPad application was presented to the child and parent immediately before the imaging procedure, in a treatment or waiting room, before entering the imaging department. The child held the iPad and touched the buttons and advanced the screens of photos and sentences while listening to the voice recording of the script. After the app, the first researcher collected the post intervention measures before the imaging procedure.

Only the second researcher, who was blinded to the intervention and pre-imaging measures, accompanied the child and parent to imaging. The second researcher completed the BOT and information on the use of medications, sedation, restraints and completion time. Each parent and child received a $15 department store gift card to thank them for their time.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences SPSS 19.0 (SPSS, 2010). Demographic data were examined using descriptive statistics. Frequencies were performed on types of imaging procedures and comments on restraints, medications and behaviors captured by the second researcher. Repeated measures were done on the physiologic measures (pre-post scores) for changes in child HR, and BP, and state-anxiety measure for parents (STAI-S), (pre-post scores) from baseline to post app.

Next, the data on the behaviors captured in the BOT subscales and procedure length time stamps from the second researcher, collected during imaging, were analyzed. Chi-square analysis was performed for the number of challenging behaviors per scheduled procedure compared between the app and the TAU groups. Because the data violated the assumptions of the parametric tests, a Mann–Whitney *U* test was performed for time differences for D1, D2 and D3. Cohen's d effect sizes were calculated to determine the standardized difference between the app and TAU group. A small effect is considered to be 0.2, a medium effect is 0.5, and a large effect is 0.8 (Cohen, 1992).

Results

There were 32 parents and 32 children in the study. The majority of the parents were college educated (*n* = 22, 78.6%), White (*n* = 24, 85.%), married (*n* = 22, 78.6%), mothers (*n* = 23, 71.8%), of male children (*n* = 24, 82.8%), with a mean age of 10.3 years (*SD* = 5.1) (Table 2).

Table 2. Demographics *N* = 32 parent/child dyads.

Parent gender	**Number**	**%**	
Female	23	71.8	
Male	7	21.9	
Missing	2	6.3	
Child gender			
Male	24	82.8	
Female	5	17.2	
Missing	3		
Parent race			
White	24	85.7	
Hispanic	2	7.2	
African American	2	7.2	
Missing	4		
Parent marital status			
Married	22	78.6	
Divorced	1	3.6	
Other	5	17.9	
Missing	4		
Child ASD DSM-IV diagnosis			
Autism	12	38.7	
PDD-NOS*	10	32.3	
Aspergers	9	29.3	

Missing	1		
Parent education			
College graduate	11	39.3	
Some college	11	39.3	
High school graduate	3	10.7	
Some high school	3	10.7	
Missing	4		
	Mean (years)	*SD*	Range (years)
Parent age	43.2	9.4	26–61
Child age	10.3	5.1	0–19

∗Pervasive development delay – Not otherwise specified.

There was a wide variety of imaging procedures (Table 3), with chest and abdominal x-ray being the most common (*n* = 13, 40.6%). All the images in both the intervention and the control group were completed successfully. Due to the variety of the types of imaging and the different time requirements that each traditionally requires, time stamps D1, D2, and D3 were measured with the intention to use the D2 time stamp across interventions to compare procedure times.

Table 3. Imaging procedure frequencies (*N* = 32).

	iPad intervention	**Control**
Imaging procedure	***n* (%)**	***n* (%)**
Chest x-ray	3 (9.4)	7 (21.9)
Abdomen x-ray	1 (3.1)	2 (6.3)
Upper G.I. x-ray	0	2 (6.3)
Neck x-ray	1 (3.1)	0
Skull x-ray	0	1 (3.1)
Arm x-ray	1 (3.1)	0
Scoliosis x-ray	1 (3.1)	0
Shunt series x-ray	0	1 (3.1)
CT scan head	4 (12.5)	2 (6.3)
MRI knee	1 (3.1)	0
MRI spine	1 (3.1)	0
Ultrasound-abdomen	2 (6.3)	0
Swallow study	1 (3.1)	0
G-J tube replacement		
Total	16 (50)	16 (50)

Comments recorded about the children in the intervention group focus on restraints, medications, and child behaviors. One child had “wrist and upper arm restraints for an X-Ray”, and one child “chewed his thumb.” One child held a parent's hand, and two children were noted to be calm throughout the imaging procedure. Two children wore “seat belts” during CAT scans. A child undergoing an x-ray for a broken arm received morphine for pain along with regular medications: lamictal, for mood, and

buspar, for anxiety. Thus, medication and restraint use is another variable impacting the imaging time and challenging behaviors.

In the control group, comments reflect that restraints were used and children asked a lot of questions. One child had “wrist and hand restraints,” noted as “standard of care” by the technician, and two other children were reportedly “held down, which can be normal treatment.” Four children were talkative: “very talkative,” “talked the entire time,” “asking a lot of questions,” and had “frequent questions.” One child in the control group was “whining, no tears,” and one was “very active in the room.” One child in the control group had regular medications, clonidine (for hyperactivity), and risperdal (for aggression).

Hypothesis 1 stated that children with ASD who are exposed to the app to prepare for medical imaging compared with children with ASD exposed to TAU will have: (1) lower anxiety as measured by heart rate and blood pressure, (2) exhibit fewer challenging behaviors as measured by all 3 subscales of the BOT, and (3) shorter time to complete a procedure as measured by D2. Pre and post intervention mean child HR and systolic BP for both the TAU and app groups are presented in Table 4. The change in mean HR was greater for the intervention group (drop of 4.8 beats/minute) compared to the control group (drop of 2.3 beats/minute). Child systolic BP decreased in the intervention group (5.6 mmHg) and rose in the control group (8.7 mmHg).

Table 4. Pre and post iPad app intervention and control group child stress measures.

		Pre intervention		**Post intervention**		**Pre-Post Difference**
	N	**Mean (SE)**	**95 % CI**	**Mean (SE)**	**95 % CI**	
HR∗						
Control	8	98.1 (5.6)	86.4–109.9	95.8 (4.6)	86.2–105.3	− 2.3
Intervention	12	95.8 (4.6)	86.2–105.3	91.0 (5.4)	79.6–102.4	− 4.8
BP∗∗						
Control	8	105.5 (6.9)	90.9–120.1	112.5 (5.8)	100.3–124.7	+ 8.7
Intervention	12	119.8 (5.7)	107.8–131.7	114.2 (4.7)	104.2–124.1	− 5.6

∗Heart rate (beats/min).

∗∗Systolic Blood pressure (mmHg).

Children in the control group had higher mean number of challenging behaviors in 2 of 3 subscales of the BOT. There was a small effect size = 0.4 for the A subscale, and a medium effect size =. 56 for the C subscale (Table 5). This subscale has items such as “moving around room/exploring,” “throwing items,” “pinching other person.” The mean number of challenging behaviors on the B subscales was similar across groups.

Table 5. Behaviors of children during imaging for the control and intervention groups.

	Control		**Intervention**		
	n*	**Behavior (Yes/No)**	***n***	**Behavior (Yes/No)**	**Effect size**
A. Internalized	11	0/11	13	1/12	0.02

B. Self-stimulatory	12	2/10	14	5/9	0.40
C. Externalized/Activity	13	9/4	14	6/8	0.56
Total	36	11/26	31	12/29	

∗*n* varies due to missing data.

Times for the imaging are presented in Table 6. The imaging procedure's time in the imaging room was less for the intervention group compared to the control only for the time period D2. The effect size was only 0.15. Also, the Mann–Whitney *U* test was performed on the differences in times to complete the 3 stages of the respective imaging procedures, D1, D2, and D3 between the control and the intervention group (Table 6). For all three of the time stamps (D1, D2 and D3), the null hypothesis was retained, which means that by using this statistical test, there is no statistically significant change in the times for the stages of imaging with this small sample of diverse imaging.

Table 6. Times for stages of imaging for intervention and control groups, and null hypothesis testing.

	Intervention or control	***n***	**Mean (minutes)**	**Std. deviation**	**Std. error mean**	**Difference (minutes)**	**Effect size**	***p***
D1	Control	14	1.43	1.45	0.39	+ 0.50		0.63
	Intervention	15	1.93	2.71	0.70			
D2	Control	14	4.07	2.70	0.72	− 0.47	0.15	0.29
	Intervention	15	3.60	3.48	0.90			
D3	Control	14	8.00	6.74	1.80	+ 7.07		0.14
	Intervention	14	15.07	17.66	4.72			

$p < 0.05$.
D1 = T2 (time on table) – T1 (time in the imaging room).
D2 = T3 (time imaging started) – T2 (time on table).
D3 = T4 (time all done) – T3 (time imaging started).

Hypothesis 2 stated that compared to parents of ASD children exposed to TAU, parents of children with ASD who are exposed to the app will have: (1) lower state anxiety as measured by the State Anxiety Inventory. Pre and post intervention parent state anxiety for both the control and intervention groups are presented in Table 7. Change in state anxiety was greater for the app (drop of 0.6 points) compared to the control group (rise of 2.5 points). There was a small effect size of 0.33.

Table 7. Parent state anxiety from pre to post iPad app intervention.

	Pre iPad intervention		**Post iPad intervention**			
	Mean (SE)	**95 % CI**	**Mean (SE)**	**95 % CI**	**Change**	**Effect size**
Control (*n* = 16)	36.46 (3.42)	29.37–43.55	39.0(4.1)	30.61–47.54	+ 2.5	0.33
Intervention (*n* = 16)	33.73 (3.72)	26.02–41.33	33.09(4.4)	23.89–42.3	− 0.6	

Discussion

This pilot feasibility study is the first to examine the effectiveness of a social script intervention "Going to Imaging" application (app) on anxiety, challenging behaviors, and procedure duration among children with ASD, and the anxiety of their parent. The findings only support the study hypotheses when consideration is given to the effect sizes. With small samples of diverse procedures, standardized difference between the control and intervention group can detect differences between groups (Cohen, 1992). Thus, given our small sample, it was important to report these effect size findings as indicative of group differences.

For the first hypothesis, children with ASD who were exposed to the app were compared with children with ASD exposed to TAU. The children with the app had lower anxiety as measured by heart rate and systolic blood pressure, exhibited fewer externalized challenging behaviors as measured by the C subscale of the BOT and had a shorter time to complete the D2 part of the procedure. In terms of measuring the child anxiety, more children with the app (12/16) allowed vital signs (HR and BP) compared to the control group (8/16). As a result, there are fewer measures of the child anxiety, which is measure of the stress response, than the anxiety/stress measure for the parent. A large percentage of children with ASD have anxiety (De Bruin et al., 2007, Simonoff et al., 2008). Our findings match other literature showing social stories help prepare the child and parent for new social situations (Brewer et al., 2006, Drake et al., 2012, Kokina and Kern, 2010). The children with the app allowed vital signs, which may mean that they had decreased anxiety. BP and HR increase as part of the stress response (Lazarus, 1999), thought to represent anxiety.

In terms of measuring challenging behaviors, the children in the control group had more externalized challenging behaviors, as noted on the C subscale, than the children in the intervention group. In the text box that allowed the researcher to write in additional behaviors that were not on the BOT, researcher 2 wrote down the child's continued questioning as a behavior for children in the control group. This behavior could represent a lack of understanding of the steps of the imaging procedure.

The items in the C subscale relate to externalized behaviors of injury to others and hyperactivity. They are the most challenging of the 3 domains of challenging behaviors in the BOT and therefore noting a difference in this subscale is an important finding. The other two subscales of the BOT measured self-injury and self-stimulatory behaviors, which though challenging, tend to be self-calming mechanisms used by children with ASD, when stressed (Johnson & Rodriguez, 2013). Our findings match literature, which hypothesizes that the use of nuanced approaches, such as a social script iPad app, is thought to cue acceptable behaviors for a child with anxiety and ASD (Gray, 2003, Koller and Goldman, 2012) and promote self-regulation (Thompson & Johnston, 2013).

One behavior of the children who did not receive the app included moving around the imaging room, which prolonged D2. One child was held down, which was reported by the HCP as standard care. This practice highlights the unmet needs of this vulnerable population of children with ASD to being physically restrained. It also matches past research on the parent perspective that environments in which medical procedures are performed are not prepared to address the anxiety and challenging behaviors of their children (Bultas, 2012, Kopecky et al., 2013). Likewise it matches reports noting that

nurses who are under time pressure may not understand the different needs for procedure preparation for children with ASD (Tucker and Spear, 2006, Tucker et al., 2008).

For the second hypothesis, compared to parents of children with ASD exposed to TAU, parents of children with ASD who are exposed to the app had lower STAI-S. This finding was predicted by the FSM framework that describes family member routine use of condition management in every day family life (Knafl et al., 2013) to cope with their child's stress and behavior (Larson, 2010, Woodgate et al., 2008). In the present study, the app strengthens child protective factors of lower anxiety, challenging behaviors, and family outcomes of lower parent anxiety. Moreover, the findings of the study affirm the need for nurses to partner with parents in procedure preparation for imaging, as noted in past research (Johnson and Rodriguez, 2013, Johnson et al., 2013).

Our study identified other factors that could affect study outcomes. For example, some children received medications and some children's parents went back to imaging and others did not. The FSM framework predicts that there are family risk and protective factors that impact family outcomes. The parent anxiety could be a risk factor, and although it did decrease in the present study, it is not a large decrease, and it may not have decreased in all parents. Past literature also showed other sources of parent anxiety related to medical imaging (Johnson and Rodriguez, 2013, Johnson et al., 2013). Seminal research on a key source of parent anxiety for children with chronic conditions is a lack of trust with HCPs based on past experiences with them (Thorne & Robinson, 1989). Based on this literature, anxiety reducing parental consultation would include asking the parent: (1) how they prepared the child for the procedure before coming to the medical setting, (2) the child's past exposure to the procedure, (3) how they want to be involved with the procedure, and (4) the reward their child will earn for participating in it (Johnson and Rodriguez, 2013, Johnson et al., 2013). Accordingly, adding this interaction to the iPad intervention could strengthen the protective factors that positively impact the individual and family outcomes. As such, further research is needed to explore the impact of these and other factors that affect child and parent anxiety, child challenging behaviors and procedure time.

Our study was limited by a small sample size, and the heterogeneous group of imaging procedures, and the wide variety of chronological ages and possibly varying development of children with ASD. The ASD diagnosis is by parent report, according to DSM-IV criteria, which is also considered a limitation. Furthermore, it cannot be determined for certain whether the child completed the app or paid attention to it. Based on the effect sizes, a larger sample, to be determined by a power analysis, is needed to determine statistically significant differences for the proposed relationships between the app and TAU group outcomes.

Conclusion

Koller and Goldman (2012) encouraged research on nuanced approaches that work best for children with high anxiety such as ASD, who may be unable to engage in active distraction for procedure preparation. Preliminary results of the present study demonstrate feasibility of our iPad social script app approach, based on principals of the FSM framework, which demonstrated small to medium effect sizes on challenging behaviors and time to complete one part of the imaging procedure. Use of the app also has a relationship with anxiety as measured by HR and systolic BP in children and is trending towards a positive effect on state anxiety in parents. These findings highlight the need to collect

additional data to demonstrate efficacy, and for future studies expanding the procedure preparation for parents. The app has the potential to change health care practices for procedure preparation for children with ASD.

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